Forces and Equilibrium Worksheet

1.

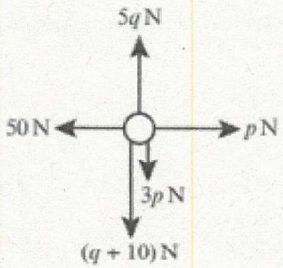
A trapeze bar is suspended motionless from the ceiling by two ropes. Draw a force diagram to show the forces acting on the ropes and the trapeze bar.

2.

A car's engine applies a force parallel to the surface of a horizontal road that causes the car to move with constant velocity. Considering the resistance to motion, draw a diagram to show the forces acting on the car.

3.

The diagram shows a particle acted on by a set of forces.
Given that the particle is at rest, find the value of p and the value of q.

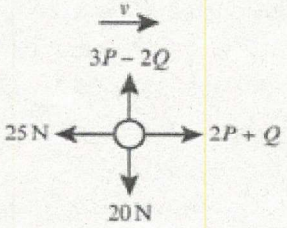


4.

Given that the particle in this diagram is moving with constant velocity, v, find the values of P and Q.

Problem-solving

Set up two simultaneous equations.



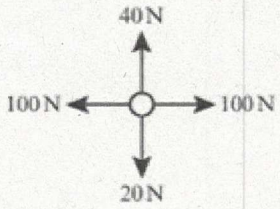
5.

Each diagram shows the forces acting on a particle.

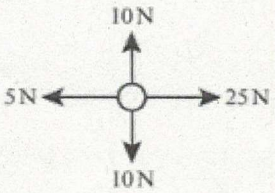
i Work out the size and direction of the resultant force.

ii Describe the motion of the particle.

a



b



6.

A truck is moving along a horizontal level road. The truck's engine provides a forward thrust of 10 000 N. The total resistance is modelled as a constant force of magnitude 1600 N.

a Modelling the truck as a particle, draw a force diagram to show the forces acting on the truck.

b Calculate the resultant force acting on the truck.

7.

A car is moving along a horizontal level road. The car's engine provides a constant driving force. The motion of the car is opposed by a constant resistance.

a Modelling the car as a particle, draw a force diagram to show the forces acting on the car.

b Given that the resultant force acting on the car is 4200 N in the direction of motion, and that the magnitude of the driving force is eight times the magnitude of the resistance force, calculate the magnitude of the resistance.

Problem-solving

8.

The forces $\begin{pmatrix} a \\ 2b \end{pmatrix}$ N, $\begin{pmatrix} -2a \\ -b \end{pmatrix}$ N and $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$ N act on an object which is in equilibrium.

Find the values of a and b.

9.

In this question, **i** represents the unit vector due east, and **j** represents the unit vector due north. A particle is acted upon by forces of:

a $(-2\mathbf{i} + \mathbf{j})$ N, $(5\mathbf{i} + 2\mathbf{j})$ N and $(-\mathbf{i} - 4\mathbf{j})$ N **b** $(-2\mathbf{i} + \mathbf{j})$ N, $(2\mathbf{i} - 3\mathbf{j})$ N and $(3\mathbf{i} + 6\mathbf{j})$ N

Work out:

i the resultant vector

ii the magnitude of the resultant vector

iii the bearing of the resultant vector.

10.

The forces $(2a\mathbf{i} + 2b\mathbf{j})$ N, $(-5b\mathbf{i} + 3a\mathbf{j})$ N and $(-11\mathbf{i} - 7\mathbf{j})$ N act on an object which is in equilibrium. Find the values of a and b.

11.

Three forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ acting on a particle P are given by the vectors $\mathbf{F}_1 = \begin{pmatrix} -7 \\ -4 \end{pmatrix}$ N, $\mathbf{F}_2 = \begin{pmatrix} 4 \\ 2 \end{pmatrix}$ N and $\mathbf{F}_3 = \begin{pmatrix} a \\ b \end{pmatrix}$ N, where a and b are constants.

Given that P is in equilibrium,

a find the value of a and the value of b. **(3 marks)**

b The force $\mathbf{F}_1$ is now removed. The resultant of $\mathbf{F}_2$ and $\mathbf{F}_3$ is $\mathbf{R}$. Find:

i the magnitude of $\mathbf{R}$ **(2 marks)**

ii the angle, to the nearest degree, that the direction of $\mathbf{R}$ makes with the horizontal. **(3 marks)**